

CLAIMS

Sub A-1  
5 1. A process for treating combustion exhaust gas containing CO, HC, NO, O<sub>2</sub>, soot and non-reactive gases, by the steps:

i. catalysing oxidation of NO to NO<sub>2</sub>;

ii. collecting soot on a filter from the product of i;

iii. combusting the collected soot by reaction with NO<sub>2</sub> and possibly also O<sub>2</sub> left over after the reactions in i;

10 iv. removing NO<sub>x</sub> from the product of iii by the action of a regenerable NO<sub>x</sub> absorbent;

v. regenerating the absorbent intermittently by:

(a) decreasing the net oxidant level by injecting reductant upstream of the absorber but downstream of the oxidation catalyst; and/or

(b) injecting a NO<sub>x</sub>-specific reactant upstream of said absorbent; and

15 vi. at least during said regeneration, subjecting the gas leaving the absorbent to a catalyst system effective to promote reactions of HC and CO with O<sub>2</sub> to H<sub>2</sub>O and CO<sub>2</sub> and to react NO<sub>x</sub> to N<sub>2</sub>.

2. Process according to claim 1 in which the NO<sub>x</sub> absorber comprises:

20 (a) compounds of alkali metals, alkaline earth metals, rare earth metals and transition metals, capable of forming nitrates and/or nitrites of adequate stability in absorbing conditions and of evolving nitrogen oxides and/or nitrogen in regenerating conditions; and/or

(b) adsorptive materials such as zeolites, carbons and high-area oxides.

25 3. Process according to claim 1 or claim 2 in which in the absorber the catalyst system of step vi is associated with the absorbent.

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30 4. Process according to any one of the preceding claims in which the catalyst system in step vi includes a separate bed following the absorber.

5. Process according to any one of the preceding claims in which the catalyst associated with or following the absorber comprises vanadia/titania and/or one or more platinum group metals.

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6. Process according to any one of the preceding claims in which reductant or reactant is introduced after step iii.

7. Process according to any one of the preceding claims in which the reductant is a hydrocarbon, hydrogen or dehydrogenatable organic compound.

8. Process according to claim 7 in which the air/fuel weight ratio of the exhaust gas containing injected reductant is in the range 10 to equivalence.

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9. Process according to any one of claims 1 to 6 in which the NOx-specific reactant is ammonia or hydrazine and is injected as such and/or as a precursor compound decomposable thereto in situ.

10. Process according to claim 9 in which ammonia is injected as urea or aqueous urea solution.

11. Process according to claim 9 or claim 10 in which the reactant is injected into:  
(a) lean exhaust gas as generated by the engine or as issuing from a preceding step of exhaust treatment; or  
(b) such gas to which reductant short of equivalence has been or is being added; or  
(c) gas made leaner, for example when the NOx-specific reactant is injected with the aid of air.  
(d) rich or equivalent gas or gas into which reductant has been introduced eg to provide for reaction increasing gas temperature but leaving the gas net-lean in composition.

12. Process according to any one of claims 9 to 11 in which the reactant is injected upstream of the filter.

13. Process according to claim 12 in which the filter is non-catalysed.

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14. Process according to claim 12 or claim 13 in which the reactant is injected upstream of the oxidation catalyst.

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15. Process according to any one of the preceding claims in which the exhaust gas is the product of combustion of a fuel containing less than 50 ppm w/w of sulphur.

16. System for treatment of combustion exhaust gas having integers corresponding to the process according to any one of the preceding claims.

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17. System according to claim 16 comprising, in combination and in order: a catalyst effective to promote oxidation of at least NO to NO<sub>2</sub>; a filter effective to collect soot and hold it for combustion reaction with the NO<sub>2</sub> in the gas; a NO<sub>x</sub> absorber charged with solid absorbent; means for introducing intermittently a regenerant of the absorber, such means being effective to introduce reductant upstream of the absorber but downstream of the oxidation catalyst; and/or to introduce a NO<sub>x</sub>-specific reactant upstream of the absorber; and, associated with and/or downstream of the absorber a catalyst system effective to promote reactions of HC and CO with O<sub>2</sub> to H<sub>2</sub>O and CO<sub>2</sub> and to react NO<sub>x</sub> to N<sub>2</sub>.

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18. A diesel engine having a system according to claim 16 or claim 17 connected to its exhaust outlet.

19. An engine according to claim 18 which is of the turbo-charged direct injection type.

20. A process, system or engine according (as appropriate) to any one of the preceding claims, including sensors, indicators, computers and actuators, effective to maintain operation within desired conditions.

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21. A process, system or engine substantially as described and as illustrated by the foregoing specific description.

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22. A process, system or engine according (as appropriate) to any one of the preceding claims, operated in compliance with the European Stage IV emission legislation.